CHEMICALS

Project Fact Sheet

Compact and Efficient Chemical Reactor

Benefits

- Supports the deployment of fuel cells in autombiles, which could save 36 million Btu annually
- Fuel cell use could save 21 trillion Btu annually by 2010
- Improves uniformity of operation
- Increases use of stranded gas in the petroleum industry
- Reduces emissions from automobiles
- Offers a simple, robust design

Applications

The new chemical reactor is particularly applicable in producing synthesis gas (syngas) for fuel cells in the utility and automotive industries. The reactor's compact design allows it to achieve both high heat transfer and thermal effectiveness. This design is also particularly suitable for many typical catalytic chemical reaction processes in the chemical and petroleum industries.

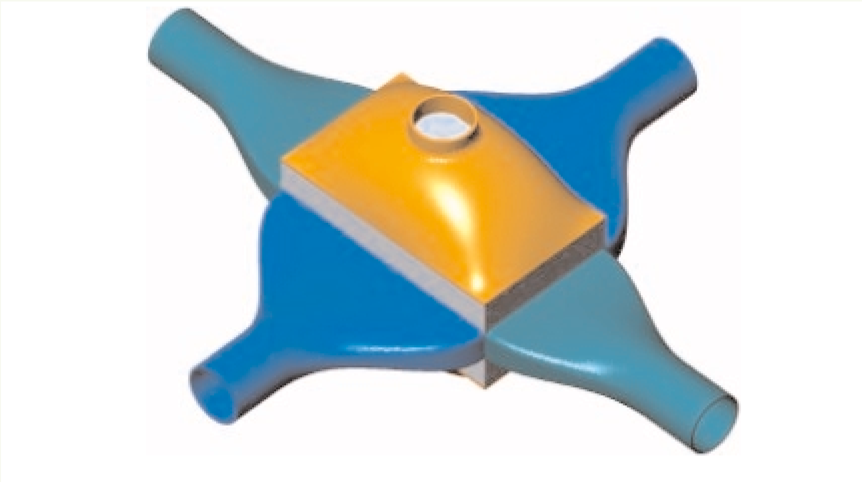
A new chemical reactor promises significant energy savings and emissions reductions

In industry today, many chemical processes are constrained by thermal factors. The limited ability to transfer heat into or out of the reacting flow in standard reactor types forces the use of much more dilute chemical streams and results in larger reactors with greater pumping-power requirements.

In the chemical industry, reactor designs for strongly endothermic and exothermic catalytic reactions have remained fundamentally unchanged over the last 20 years. The reactors in use today are much larger and less efficient than necessary. In addition, poorer efficiency and more dilute chemical streams contribute to more difficulty in transportation, storage, and disposal of hazardous substances.

A new chemical reactor proposed by Mesoscopic Devices, LLC, is designed to overcome these problems. The excellent heat transfer of the proposed reactor should allow higher-concentration reactants as well as reduced flow rates, pressure drops, and pumping-energy consumption. The compact size also enables point-of-use production of hazardous chemicals; and on-site production reduces transportation, storage, and disposal requirements.

Compact Chemical Reactor



The new reactor, being developed by Mesoscopic Devices, uses mesoscale passages and advanced catalysts to enable high power density, resulting in a more compact and efficient reactor.

Project Description

Goal: Develop and build a compact chemical reactor and demonstrate the performance improvements over standard reactor technology.

Mesoscopic Devices is developing an advanced chemical reactor designed to increase power density by a factor of 10 or more over conventional reactor designs. The new design's unique flow configuration and small flow passages improve heat transfer, chemical conversion rates, and reactor size.

The new reactor design uses mesoscale (~100-micrometer) passages and advanced catalysts to enable extremely high density. The reactor combines the high mass transfer rates possible in mesoscale reactors with mesoscale heat exchangers. The very high power density minimizes the reactor mass, allows rapid startup, and simplifies operation in systems with rapidly varying loads.

Mesoscopic Devices is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the U.S. Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Upgrade the analytical models used to predict heat transfer, chemical reaction rates, and pressure drop of reactants.
- Design and fabricate a prototype reactor.
- Test the prototype to demonstrate the improved performance of the reactor.
- Update the market analysis and business plan based on test results.

Economics and Commercial Potential

The new chemical reactor offers significant potential for achieving high chemical conversion rates and conserving energy. The primary end use for this technology is in producing fuel for fuel cells in the utility and automotive industries.

Mesoscopic Devices' commercialization success will depend on the production of syngas and the reforming of hydrocarbons. Syngas production is a basic chemical reaction conducted at more than 10,000 facilities worldwide. Methane reforming, on the other hand, is only applicable to stationary fuel cells in the utility industry for distributed power and independent power production. The market size for stationary fuel cells is expected to exceed $10 billion by 2010, based on a study by Allied Business Intelligence. This study also predicts fuel cells will be in 4% of all automobiles sold in the United States by 2010, or over 600,000 new vehicles per year.

This enabling technology would support fuel cell deployment, which could save 36 million Btu per automobile each year. First sales for the technology are expected by 2003. Based on 2% market penetration by 2010, annual savings could be 21 trillion Btu with 600,000 units operating. Market penetration of 5% by 2020 could save 180 trillion Btu from 5,000,000 operating units.

INDUSTRY OF THE FUTURE—CHEMICALS

*The chemicals industry is one of several energy- and waste-intensive industries that participate in OIT's Industries of the Future initiative. In December 1996, the chemicals industry published a report entitled **Technology Vision 2020: The U.S. Chemical Industry** that helps establish technical priorities for improving the industry's competitiveness and develops recommendations to strengthen cooperation among industry, government, and academia. It also provides direction for continuous improvement through step-change technology in new chemical science and engineering technology, supply chain management, information systems, and manufacturing and operations.*

OIT Chemicals Industry Team Leader: Paul Scheihing (202) 586-7234.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

FOR PROJECT INFORMATION, CONTACT:

Dr. Jerry L. Martin
Mesoscopic Devices, LLC
510 Compton Street, Suite 106
Broomfield, CO 80020
Phone: (303) 466-6968
Fax: (303) 466-6871
jmartin@mesoscopic.com
Home Page:
www.mesoscopic.com

FOR PROGRAM INFORMATION, CONTACT:

Lisa Barnett
Program Manager
Inventions & Innovation Program
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585-0121
Phone: (202) 586-2212
Fax: (202) 586-7114
lisa.barnett@ee.doe.gov

FOR PROJECT UPDATES:

Visit our home page at
www.oit.doe.gov/inventions

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121

Order# I-CH-819
September 2001